10/559492
IAP12 Rec'd PCT/PTO 05 DEC 2005

Linear indicator

The present invention relates to an analog display instrument, in particular for use in motor-vehicle dashboards, with the instrument having an indicator which moves in front of a scale.

A large variety of indicator instruments of this type have long been known. In the known instruments, an indicator is usually moved around a circle or a segment of a circle, with the indicator being held at the top of a shaft which is driven by a stepper motor. The movement of the indicator is therefore restricted to a corresponding circular path. This enforced circular movement considerably restricts possible designs when developing such instruments. The installation space and the area required on the display panel, specifically, are relatively large, with the result that limits are set on the miniaturization of the instruments to maintain readability. A high degree of outlay in terms of design is also needed if, in order to save space, a plurality of displays equipped with indicators are to be arranged such that their angular regions overlap.

In addition to these circular displays, instruments whose indicators are formed by an arrow whose length changes and which extend linearly along a scale are known from the vehicle industry. This solution was not successful on account of the high technical outlay required for mimetic adjustment and the associated increase in the susceptibility of the instruments to faults.

The object of the present invention is now to provide an analog display instrument which can be matched to any desired design requirements in a flexible manner,

can be implemented in a cost-effective manner using simple means, and enables information to be read off exactly.

This object is achieved by means of an instrument having the characterizing features of claim 1.

The central idea of the invention is to move the indicator linearly in front of the scale. This movement takes place along a guide which is in the form of a straight line or a curve depending on the respective requirement. In this case, the curve may be of any desired shape, for example can also assume the shape of an arc of a circle. However, it is advantageous if the curve is continuous and does not have any kinks.

The indicator, or the slide on which the indicator is seated, is made to move in both movement directions by an electrically controllable drive. This drive may drive the indicator or the slide either directly or indirectly. Direct driving may be performed by a motor which is directly connected to the indicator. A motorized slide of this type which is fitted with an indicator would then move along the guide, it being possible for the guide to be in the form of a rail. Indirect driving may be performed by a fixed motor which moves the slide along the guide with the aid of transmission means, such as cable pulls or flexible shafts.

Even when it is possible to use an indirect drive of this type to move an indicator along curved, wavy or looped curves by means of a corresponding guide in a positively guided manner, it is particularly advantageous when the indicator is arranged on a slide which is positively guided along the guide and can be moved directly by a drive which is likewise seated on the slide. A slide of this type then moves with its own drive along the guide. The slide is controlled in each

case as a function of the measured variable which is to be shown by the instrument. Therefore, the distance travelled by the slide, the distance it covers from a zero point, corresponds to the current speed of the vehicle, for example.

An indicator instrument of this type has various advantages: the decisive advantage is certainly the flexibility of design of the scale which can now be arranged in any desired curves on the dashboard. The invention now makes it possible to match the analog instruments to the conditions on the display panel and thus divide up the available space effectively. In addition, the ability to see the instruments can be increased by the deliberate use of optical effects when designing said instruments. Another advantage is that the invention provides a high degree of scope for particularly unusual design features which can be matched to the style of the respective type of vehicle. The instruments according to the invention can be implemented in a comparatively cost-effective manner using the means which are commercially available nowadays.

The motor which drives the slide may be a conventional stepper motor. If this motor is seated on the slide, it can move along a guide which is equipped with teeth. The position of the indicator is then determined by means of the number of steps made and counted by the motor.

However, in order to minimize the outlay on design, it is particularly advantageous when the drive, which in particular is seated on the slide, is a linear drive. A linear drive of this type can make the slide move linearly on the guide without further components, such as gear mechanisms. In this case, various types of linear drives, in particular AC and DC linear motors, are known. However, on account of the particular

potential for further miniaturization and on account of the advanced developments, linear drives with a piezomotor are preferred, with this piezomotor moving along the fixed guide which is in the form of a rod, in particular. In this case, a drive part of the piezomotor engages on the guide in a non-positive manner. A particularly simple embodiment of the piezomotor is seated displaceably on the rod and moves with the aid of a vibration element which is excited so as to produce elliptical movements and is part of the drive element. The slide can be displaced at any desired speed with a drive of this type.

One problem with the linear drives, in particular the said piezomotors, is that the distance covered can only be reproduced within certain limits. If a piezomotor of this type makes a specific number of steps in one direction, there is no guarantee that the same number of steps in the other direction will lead precisely to the same starting point. For this reason, it is advantageous to provide a sensor system which is independent of the piezomotor and which can be used to observe the current position of the slide. In one advantageous embodiment of the invention, the indicator position in relation to the guide and/or in relation to the scale can therefore be established using the sensor system. The variables obtained by means of the sensor system are advantageously used as the basis of a control process.

Different embodiments for a sensor system of this type are feasible: on account of the simple and cost-effective design and on account of the accuracy of the determined variables, it is advantageous to form a voltage divider circuit with the slide which is fitted with the indicator. To this end, an electrically conductive track with the most homogeneous resistance possible is advantageously fitted along the rod, on which track a current collector which is fitted on the

slide rests. If a maximum voltage is now applied over a distance of the track, in particular between the starting position (zero position) and a maximum position of the slide, a partial voltage can be tapped off across the current collector. In one particularly simple and robust embodiment, the entire rod is produced from conductive material with a defined resistance, in particular from a plastic interspersed with carbon. In another variant, the rod may also be surrounded by a winding on whose stripped surface the current collector can be displaced.

The voltage divider circuit is advantageously formed in such a way that the ends of the track travelled by the slide and the tap of the current collector are connected to form a measuring bridge. The position of the current collector on the track can be determined in the known manner from the ratio of the voltages. The actual position of the indicator in relation to the scale can be determined from the position of the current collector. In this case, it is advantageous to provide a control loop which forwards the actual position of the indicator to a controller as an input variable which said controller compares with a prespecified desired position, with the controller forwarding the control difference to the piezomotor as an output variable. The desired position is determined from the measured variable, for example the measured speed.

In general, the analog values can be converted by means of an analog/digital converter (ADC) and processed in a microprocessor. In this way, the indicator position can be reliably calculated, it being possible to adjust the accuracy of the calculation by means of the resolution of the ADC used.

In order to be able to reproduce the positioning of the piezomotor, the desired and actual positions can also

be adjusted by means of a circuit for adjusting the zero point in a simple embodiment. This circuit performs the adjustment, for example, when the indicator is in its starting position. Adjustment of this type may replace the control process or else be provided in addition to the control process.

It is possible to use the vibration element which is in contact with the track as the current collector. This simplification obviates the need for an additional component, and this contributes to increasing the reliability of the instrument and saving costs.

One particular embodiment of the invention is described in greater detail below and illustrated in figures 1 and 2, in which:

figure 1 shows a schematic illustration of an instrument according to the invention, and

figure 2 shows a detail of the instrument.

Figure 1 illustrates an instrument for displaying speed which can be used in motor-vehicle dashboards. The instrument has an indicator 2 which moves in front of a scale 1 and can be illuminated in a known manner. The instrument has a guide 3 which is in the form of a shaft, it being possible for the indicator 2 to be moved linearly along the guide in the forward and backward directions by an electrically controllable drive 4. The drive 4 is connected to a power source 6 via thin wires 5. In this case, the drive is a piezomotor which moves along the fixed and guide 3, with a drive part 7 of the piezomotor engaging on the guide 3 in a non-positive manner. In this embodiment, the piezomotor has a slide 8 which is positively guided along the guide 3 using rollers 9. The guide 3 is formed by a rod which is composed of plastic interspersed with carbon and on which the piezomotor is

seated, with the piezomotor having a drive part with a vibration element 7 which engages on the rod 3 and whose tip is excited so as to produce elliptical movements (arrow A) and thus push off from the rod 3. A piezoceramic 10 is fitted on the vibration element 7 and is excited by an applied AC voltage. The vibration element 7 is held on the slide 8 by means of a spring 11.